

Frequency of Bacterial Isolates in Blood Culture among Patients with Acute Pyogenic Meningitis

Bacterial Isolates
in Blood Culture
with Acute
Pyogenic
Meningitis

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ABSTRACT

Objective: To determine the frequency of bacterial isolates in blood culture among patients with acute pyogenic meningitis.

Study Design: Descriptive / cross-sectional study

Place and Duration of Study: This study was conducted at the Department of Medicine, Qazi Hussain Ahmad Medical Complex, Nowshera from November, 2017 to May, 2018.

Materials and Methods: A total of 193 patients using 43.4% proportion of positive blood culture with acute bacterial meningitis, 95% confidence level and 5% margin of error, using WHO software, presenting features of pyogenic meningitis were included in the study and subjected to blood culture to record the findings.

Results: The mean age group of our sample was 32.4 ± 10.9 years of which 66.8% male patients and 33.2% female patients. Most of the patients i.e. 59.6% were in the age group up to 35.00 years. Positive blood culture was seen in 60.1% of cases with E Coli being the most frequent in 25% of patients followed by Pneumococcus in 22.4% of patients, Meningococcus in 21.6% of patients, Klebsiella in 9.5% and H. Influenza in 8.6%.

Conclusion: Acute pyogenic meningitis is a common occurrence in our population with E. Coli, Pneumococci and Meningococci being the common culprits.

Key Words: Acute Bacterial Meningitis, Blood Culture, Pneumococcus, Meningococcus, Klebsiella.

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INTRODUCTION

Meningitis is defined as inflammation of meninges which is caused by bacteria, viruses, fungi and parasites¹. Bacterial meningitis results in worldwide morbidity and mortality, even though adequate antibiotics and vaccination strategies have been carried out^{2,3}.

The incidence of bacterial meningitis is approximated to be 2.6–6.0 cases per 100,000 yearly in Europe and in less developed countries it might be ten times higher⁴. The mortality rate remains high in developing countries which is 16-32%⁵. Although the incidence and rates of morbidity and death related to community-acquired acute pyogenic meningitis have adequately decreased, possibly as an outcome of immunization and proper

antibiotics and related therapies, the disease still has a high number. In United States, still 10% to 20% of people die of it⁶.

Most common organisms causing acute pyogenic meningitis are “Streptococcus pneumonia”, “Neisseria meningitidis”, “Haemophilus influenza” type B, “Gram negative Bacilli” and “Staphylococcus aureus”^{1,5,7}. The organisms causing community-acquired acute pyogenic meningitis slightly differ by geographic region, by age⁷ and by time caused by a variety of factors⁸. Streptococcus pneumonia and Neisseria meningitidis are the prevailing pathogens in adults, causing 80–85% of all cases, with 30% mortality rate for the Pneumococcal meningitis and 10% for Meningococcal meningitis^{2,9}.

Meningitis might be related with notable mortality even after treatment instituted¹⁰. One in four adults might die with acute pyogenic meningitis and many treated retain neurological deficit. Early and appropriate antibiotics needs quick recognition of the disease causing organism. The vague clinical presentation and non-availability of laboratory facilities can delay or concealed the diagnosis¹¹.

Extra-meningeal infection is examined when a patient had a focal infection away from the central nervous system and the same pathogen was segregated from the primary focus or from blood culture⁸. In one study, the frequency of positive blood culture among patients having acute pyogenic meningitis was 52.6%¹¹.

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Another study concluded that the blood cultures were more likely to be positive (43.4% in non-elderly and 51.5% in elderly) in patients with suspected acute pyogenic meningitis⁸. Cerebrospinal fluid (CSF) culture were positive in 72.4% in non-elderly and 67.8% in elderly in patients with suspected acute pyogenic meningitis⁸.

The current study is designed to find out the frequency of bacterial isolates in blood culture among patients presenting with cases of acute pyogenic meningitis. As mentioned above, the bacteriology of acute pyogenic meningitis varies from population to population with variations among age and changing patterns on time. It is also reported in literature that the bacteria found in acute pyogenic meningitis can often be identified on blood cultures, this study will produce local statistics about the magnitude of bacterial isolates in blood culture as this study is not done in the last five years in our local population. Sometimes lumbar puncture is contraindicated or difficult to obtain so blood culture is an alternative option for diagnosis in such patient as it is easy to obtain and transport as compare to CSF culture. The results will be disseminated among local health care providers to make them to know about the importance of blood culture in acute pyogenic meningitis.

MATERIALS AND METHODS

This study was conducted in the in the Department of Medicine, Qazi Hussain Ahmad Medical Complex, Nowshera from November 2nd, 2017 to May 3rd, 2018. Through a Descriptive Cross Sectional Study Design, a total of 193 patients using 43.4% proportion of positive blood culture in patients with acute bacterial meningitis⁸, 95% confidence level and 5% margin of error, using WHO software, presenting features of pyogenic meningitis were included in the study and subjected to blood culture to record the findings.

Inclusion criteria: All patients presenting with ABM.

- Age \geq 16 years.
- Both gender.

Exclusion criteria:

- Comorbid conditions due to any cause.
- History of antibiotics use in last three days.

The above mention conditions act as confounders and if not controlled will produce bias in the results.

Data Collection: The study was carried out after approval from hospitals ethical committee. An informed written consent was obtained from patients completing the inclusion criteria. From all recruited patients history, clinical examination, and routine investigations like Random blood sugar, Full Blood Count, Renal Function tests, Alanine Amino-transferase and CSF routine examination were collected. 10cc of venous blood was collected under aseptic conditions on arrival of patients and was sent to laboratory in 100 ml of culture bottle to detect positive growth of any

bacteria like Pneumococci, Meningococci, Escherichia Coli, Staphylococcus aureus, Hemophilus influenza and Klebsiella. CSF culture was not used in diagnostic criteria of acute pyogenic meningitis. However, CSF culture was sent as part of routine workup.

Confounders are controlled by following the Exclusion criteria. Lab tests and examination was supervised by medical specialist and pathologist.

Data Analysis: Data was recorded on Performa and statistical analysis was done by SSPS 20.0. Mean \pm SD was computed for quantitative variables like age. Frequency of bacterial isolates in blood culture in acute pyogenic meningitis was stratified among age and gender to see the effect modifications. Percentage and frequencies were computed for categorical variables like gender, Positive blood culture and bacteria like "Pneumococci, Meningococci, E. Coli, staphylococcus aureus, Haemophilus influenza and Klebsiella".

RESULTS

The study was conducted on 193 patients presenting with clinical features suggestive of acute meningitis. The mean age of the sample was 32.4 \pm 10.9 years. We divided the age in 4 different groups. In age group from upto 25.00 years, we had 40.4% of patients, in the group 25.01 to 35.00 years we had 19.2% patients, in age group 35.01 to 45.00 years we had 20.2% patients and in the age group 45.01 years and higher we had 20.2% of patients. (Table 1)

Table No.1: Age Wise Distribution of the Sample (n = 193)

	N	Min.	Max.	Mean	Std. Deviation
Age of the patient	193	18.50	51.50	32.4109	10.95584
Age Groups					
			Frequency	Percent	Cumulative Percent
Valid	Upto 25.00 years		78	40.4	40.4
	25.01 to 35.00 years		37	19.2	59.6
	35.01 to 45.00 years		39	20.2	79.8
	45.01 years & above		39	20.2	100.0
	Total		193	100.0	

Table No.2: Frequency Of Positive Blood Culture (n= 193)

	Frequency	Percent	Cumulative Percent
Yes	116	60.1	60.1
No	77	39.9	100.0
Total	193	100.0	

Table No.3: Type of Bacteria Among Positive Blood Culture (n = 116)

	Frequency	Percent	Cumulative Percent
Pneumococcus	26	22.4	22.4
Meningococcus	25	21.6	44.0
E. Coli	29	25.0	69.0
Staphylococcus Aureus	15	12.9	81.9
Hemophilus Influenza	10	8.6	90.5
Klebsiella	11	9.5	100.0
Total	116	100.0	

Table No.4:Age Wise Stratification Of Positive Blood Culture (n = 193)

			Positive Blood Culture		Total	P-value
			Yes	No		
Age Groups	Upto 25.00 years	Count	52	26	78	.002
		% within Age Groups	66.7%	33.3%	100.0%	
	25.01 to 35.00 years	Count	25	12	37	
		% within Age Groups	67.6%	32.4%	100.0%	
	35.01 to 45.00 years	Count	26	13	39	
		% within Age Groups	66.7%	33.3%	100.0%	
	45.01 years & above	Count	13	26	39	
		% within Age Groups	33.3%	66.7%	100.0%	
	Total	Count	116	77	193	
		% within Age Groups	60.1%	39.9%	100.0%	

Out of 193 patients included in the study, there were 66.8% male patients and 33.2% female patients. All the patients were subjected to collection of venous blood sample under aseptic technique and sent for culture examination. Out of 193 patients, 60.1% were found to have culture positive meningitis (Table 2) The culture was further inoculated on various media to determine the frequency of different bacteria. Out of 116 patients who were culture positive, we found that E Coli was seen in 25% of patients, Pneumococcus was seen in 22.4% of patients, Meningococcus was seen in

21.6% of patients, Klebsiella was seen in 9.5% and H. Influenza was seen in 8.6% (Table 3).

We stratified the positive blood culture with regards to age groups and observed that the difference was statistically significant with p value of 0.002. (Table 4)

We also stratified the positive blood culture with regards to different gender and observed that the difference was statistically significant with a p value of <.001 (Table 5).

We also stratified the type of bacteria found in our study with regards to age groups and observed that the difference was statistically significant with a p value of <.001. (Table 6)

We also stratified the type of bacteria found in our study with regards to gender and observed that the difference was statistically significant with a p value of <.001. (Table 7)

Table No.5: Gender Wise Stratification of Positive Blood Culture (n = 193)

			Positive Blood Culture		Total	P-value
			Yes	No		
Gender of Patient	Male	Count	90	39	129	<.001
		% within Gender of Patient	69.8%	30.2%	100.0%	
	Female	Count	26	38	64	
		% within Gender of Patient	40.6%	59.4%	100.0%	
Total	Count	116	77	193		
	% within Gender of Patient	60.1%	39.9%	100.0%		

Table No.6: Age Wise Stratification of Type of Bacteria (n = 193)

Age Groups		Type of Bacteria							Total	P-value
		Pneumococcus	Meningococcus	E. Coli	Staphylococcus Aureus	Hemophilus Influenza	Klebsiella	NA		
Upto 25.00 years	Count	0	13	3	15	10	11	26	78	<.001
	% within Age Groups	0.0%	16.7%	3.8%	19.2%	12.8%	14.1%	33.3%	100.0%	
25.01 to 35.00 years	Count	0	12	13	0	0	0	12	37	
	% within Age Groups	0.0%	32.4%	35.1%	0.0%	0.0%	0.0%	32.4%	100.0%	
35.01 to 45.00 years	Count	13	0	13	0	0	0	13	39	
	% within Age Groups	33.3%	0.0%	33.3%	0.0%	0.0%	0.0%	33.3%	100.0%	
45.01 years & above	Count	13	0	0	0	0	0	26	39	
	% within Age Groups	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	66.7%	100.0%	
Total	Count	26	25	29	15	10	11	77	193	
	% within Age Groups	13.5%	13.0%	15.0%	7.8%	5.2%	5.7%	39.9%	100.0%	

Table No.7: Gender Wise Stratification of Type of Bacteria (n = 193)

Gender		Type of Bacteria							Total	P-value
		Pneumococcus	Meningococcus	E. Coli	Staphylococcus Aureus	Hemophilus Influenza	Klebsiella	NA		
Male	Count	21	21	20	12	8	8	39	129	<.001
	% within Gender of Patient	16.3%	16.3%	15.5%	9.3%	6.2%	6.2%	30.2%	100.0%	
Female	Count	5	4	9	3	2	3	38	64	
	% within Gender of Patient	7.8%	6.2%	14.1%	4.7%	3.1%	4.7%	59.4%	100.0%	
Total	Count	26	25	29	15	10	11	77	193	
	% within Gender of Patient	13.5%	13.0%	15.0%	7.8%	5.2%	5.7%	39.9%	100.0%	

DISCUSSION

Although the incidence and rates of morbidity and death related to community-acquired acute pyogenic meningitis have adequately decreased, possibly as an outcome of immunization and proper antibiotics and related therapies, the disease still has a high number. In United States, still 10% to 20% of people die of it ⁶.

The organisms causing community-acquired acute pyogenic meningitis slightly differ by geographic region, by age. A study conducted in United States surveillance data, from 1998 to 2007, the most prevalent agent for bacterial meningitis among adults was “Streptococcus pneumoniae”. “Neisseria meningitidis” is as prevalent as “S. pneumoniae” among young adults. Listeria infections cases increases with age ⁶.

The epidemiologic characteristics of bacterial meningitis have varied dramatically over the past decades with the advent of the “Haemophilus influenzae” vaccine. In 1986, about half the cases of acute bacterial meningitis were due to “H. influenzae”, but a decade later the incidence of “H. influenzae” meningitis had been reduced by 94% ⁶.

Meningitis is inflammation of the pia and arachnoid (the inner two layers of the meninges). Acute community-acquired meningitis can develop within hours to days and can be viral or bacterial. Viral meningitis usually has a good prognosis, whereas bacterial meningitis is associated with significant rates of morbidity and death, so it is critical to identify and segregate them promptly.

Meningitis may be related with significant mortality even after institution of therapy. Nearly one in four adults with acute bacterial meningitis (ABM) will die and many survivors retain neurological deficit ¹². Early initiation of appropriate antibiotics requires prompt recognition of the infecting pathogen. The non-specific clinical presentation and lack of laboratory facilities can delay or obscure diagnosis ¹³.

Although culture is considered to be the gold standard ¹⁴, CSF turbidity, bacteria on direct Gram stained preparation ¹¹ and pleocytosis ¹¹, increase in protein and decrease in sugar are preliminary indicators. However,

culture for fastidious organism is difficult and time consuming and produce false negative results; ¹⁵ hence the detection of soluble antigens in CSF in suspected cases by the latex particle agglutination test is considered an important diagnostic tool which has a high sensitivity, specificity, simplicity in execution, rapidity, and interpretation ¹¹.

In our study, we detected a variety of bacteria through blood culture of patients who were positive. In our study, the most frequent bacteria found was E Coli 25% followed by Pneumococcus in 22.4% of patients, Meningococcus was seen in 21.6% of patients, Klebsiella was seen in 9.5% and H. Influenza was seen in 8.6%. Overall, the positive blood culture was observed in 60.1% of patients.

In one study, ABM in winter and fall was reported to be 72.9% and in another only 27.1% cases in spring and summer ^{6,16}. These changes were probably because of geographical difference.

In our study, the maximum number of cases was in the age group of 18-51.5 years. Previous studies reported that of the patients who had bacterial meningitis, 79% were older than 15 years and 45% were older than 2 years ¹⁷. In the present study however, 40.2% of the cases who had bacterial meningitis were above 35 years of age. This was probably because in the present study there were lesser isolations of pathogens. In addition majority of the patients inducted in our study belonged to the age group of 16-35 years (59.6%). Males were found to be affected more commonly. The overall male to female ratio was found to be 2.01:1, which was somewhat similar to other studies, with a ratio of 1.2:1 ^{6,18} and 1.69:1 ¹⁶.

Culture positive cases were 60.1%, slightly higher than those in previous reports ^{19,53} which denotes that culture remains the gold standard technique. E Coli 25% followed by Pneumococcus in 22.4% of patients, Meningococcus was seen in 21.6% of patients, Klebsiella was seen in 9.5% and H. Influenza was seen in 8.6%. These findings were different from those in other studies ¹⁸, probably because this study included age range

of 16-65 years unlike the other studies, which included only children.

We also stratified the type of bacteria with regards to different age groups. Here *E. coli* was frequently found in age range 25-45 years and *Pneumococcus* in the age range above 35 years, unlike in previous studies that reported *Pneumococcus* to be the most common isolate¹⁹. This was probably because the other studies included subjects with community-acquired meningitis and therefore the number of Gram-negative isolates were comparatively lower than those of the present study. In a study conducted in Nepal, ABM was found in 8.3% cases, the causative agents being “*Pseudomonas areuginosa*” (24.3%), coagulase negative *Staphylococcus* (CONS) (10.8%), and *E. coli* (2.7%), where they claimed to have hospital-acquired infection causing meningitis¹¹. Blood cultures were positive in only 60.1% cases of bacterial meningitis, which was similar to other findings with 58.4% positivity¹⁸.

In a study by Domingo P et al, the incidence of ABM 4.03/100,000 (Group I) and 7.40 /100,000 inhabitants/year (Group II) (RR= 1.84; 95%CI: 1.56–2.17, P<0.0001). Elderly patients had co-morbid conditions more frequently (P<0.0001) and more frequently lacked fever (P=0.0625), neck stiffness (P<0.0001) and skin rash (P<0.0001), but had an altered level of consciousness more often (P<0.0001). The interval admission-start of antibiotic therapy was longer for elderly patients (P<0.0001). Meningococcal meningitis was less frequent in elderly patients (P<0.0001), whereas listerial (P=0.0196), gram-negative bacillary (P=0.0065), and meningitis of unknown origin (P=0.0076) were more frequent. Elderly patients had a higher number of neurologic (P=0.0009) and extra-neurologic complications (P<0.0001). The overall mortality ratio was higher in elderly patients (P<0.0001)⁸.

In a review from US, the most common organisms that cause community-acquired bacterial meningitis are “pneumococci” and “*Neisseria meningitidis*”. The incidence of *Listeria* infection increases in patients over age 50 and in those with compromised cell-mediated immunity⁷.

In another study from India, the organisms isolated from patients of ABM were “*Escherichia coli*” 25.6%, “*Staphylococcus aureus*” 15.4%, “*Streptococcus pneumoniae*” 10.2%, “*Klebsiella* species” 10.2% and “*Pseudomonas areuginosa*” 10.2%¹¹.

In another study, streptococcus species were the most common causative micro-organism group, at 23.21% of all episodes. Its prevalence rate significantly decreased from the first 7 years of study (41.9%) to the last 10.5 years (19.2%). However, *Klebsiella meningitis* and *Staphylococcal meningitis* were more frequently noted after 1987. More than 70% of patients had at least one underlying disease or condition²⁰. In another study by Weisfelt M et al²¹, the frequency of positive blood culture was found in 30% with *Pneumococci* in 26%, *Staph. Aureus* in 24%, *H Influenza* in 8%, *E Coli* in 6%

and *Klebsiella* in 4% of patients. In another study by Change WN et al, the most frequent isolate was *Enterobacter* species (*Enterobacter cloacae*, *Enterobacter aerogenes*), *Klebsiella* species (*Klebsiella pneumoniae*, *Klebsiella oxytoca*), *Escherichia coli*, *Staphylococcus* species (*Staphylococcus aureus*, *Staphylococcus haemolyticus*), “*Pseudomonas areuginosa*”, “*Acinetobacter baumannii*”, *Enterococcus*, “*Serratia marcescens*”, “*Citrobacter diversus*”, “*Proteus mirabilis*”, “*Streptococcus viridans*” and “*Neisseria meningitidis*”. Six of the 12 cases were found to have multi-antibiotic-resistant strains²².

Thus to conclude, the findings in this study show a preponderance of *E Coli*, *Pneumococci* and *Meningococci* as the causative agent of bacterial meningitis. *H. influenzae* was isolated in very few cases. This could probably be due to the wide reach of Hib vaccination for *H. influenzae* in children even in rural and semi-urban areas. This organisms is also very delicate and die easily.

Further studies however, regarding the occurrence of other pathogens causing bacterial meningitis such as *N. meningitidis*, *Listeria monocytogenes*, and fungi such as *Cryptococcus neoformans* are required in the future, preferably using tests to detect antigens and even by polymerase chain reaction of the blood especially considering the fact that these organisms, which are established causes of meningitis were not isolated in the present study.

CONCLUSION

Acute pyogenic meningitis is a common occurrence in our population with *E Coli*, *Pneumococci* and *Meningococci* being the common culprits. Further studies regarding the occurrence of other pathogens causing bacterial meningitis such as *Listeria monocytogenes*, and fungi such as *Cryptococcus neoformans* are required in the future.

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